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Study on marble dust as partial replacement of cement in concrete

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ABSTRACT

To focus on the possibilities of using waste materials from different manufacturing activities in the preparation of innovative mortar and concrete. The marble dust from marble processing is a waste utilized. The use of this waste was proposed in different percentages both as an addition to and instead of cement, for the production of concrete mixtures. In the study, the use of marble dust collected during the shaping process of marble blocks has been investigated in the concrete mixtures as cementitious material. The study showed that marble wastes, which are in the dust form, could be used as cementitious material in concrete mixtures where they are available and the cost of construction is lower than ordinary concrete materials. The concrete is prepared containing 5, 10, 15 and 20% waste of marble dust with cement compared to the total quantity of normal concrete. The prepared mixtures were then studied in terms of their properties both in fresh and in hardened state. In particular, tests were conducted and cured at different times to find compressive strength and tensile strength with and without partial replacement of marble dust in cement concrete and for mortar also determined for 14 and 28 days. Cost was analyzed for final result.

Keywords: Cement concrete; Hardened test; Marble waste; Partial replacement.

1. INTRODUCTION

Nowadays, the ecological trend aims at limiting the use of natural raw materials in the field of building materials and hence there is an increased interest in the use of alternative materials (waste) from industrial activities, which presents significant advantages in economic, energetic and environmental terms. The main concern of using pozzolanic wastes was not only the cost effectiveness but also to improve the properties of concrete, especially durability. The advancement of concrete technology can reduce the consumption of natural resources and energy sources which in turn further lessen the burden of pollutants on the environment. Presently, large amount of marble dust are generated in natural stone processing plants with an important impact on the environment and humans. Leaving the waste materials to the environment directly can cause environmental problem (Siddharth Pareek, 2001; Corinaldesi et al. 2005; Stone 2000; Prasanna, 2007; Binici et al. 2007; Colangelo et al. 2004; Miletic et al. 2003; Duchesnea et al. 1998; Shoaiba et al. 2000; Ravindrarajah, 1992; Kearey, 2001). Hence, the reuse of waste material has been emphasized and annual output of 68 million tons of processed product is utilized.

2. OBJECTIVES

- To study the physical properties of marble dust
- To characterize the particle size of marble dust
- Explore the use of marble dust as a replacement of cement material
- Compare the strength of the normal concrete and the proposed marble dust mixed concrete
- To identify the suitable area where marble slurry concrete is utilized

3. PROPERTIES

3.1. Physical Properties

Color : White
Form : Powder
Odor : Odorless
Moisture Content (%): 1.59

3.2. Chemical Properties

Oxide compounds	Marble Dust (Mass %)
SiO ₂	28.35
Al ₂ O ₃	0.42
Fe ₂ O ₃	9.70
CaO	40.45
MgO	16.25
Density (g/cm ³)	2.80

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Table 1
Mortar Mixtures Proportions

Mix	0%	5%	10%	15%	20%
Water (ml)	344	344	344	344	344
Cement (gm)	600	570	540	510	480
Sand (gm)	1800	1800	1800	1800	1800
Marble Dust (gm)	0	30	60	90	120

Table 2
Mix Ratio (Grade M20)

Water	Cement	Fine Aggregate	Coarse Aggregate
191.6 litres/m ³	407.65 kg/ m ³	538.09 kg/ m ³	1194.4 kg/ m ³
0.47	1	1.32	2.93

Table 3
Concrete Mixtures proportion

Grade	Marble dust
M20	0%,5%,10%,15%,20%

Table 4
Compressive strength of mortar; curing strength for 14 and 28 days

Marble Dust (%)	Compressive strength of concrete cube N/mm ²	
	14 days	28 days
0	18	49.2
5	19.5	44.1
10	19.2	49.4
15	17.4	40.8
20	16.32	32.4

Table 5
Compressive strength of concrete; Curing strength for 14 and 28 days

Marble Dust (%)	Compressive strength of concrete cube N/mm ²	
	14 days	28 days
0	29.16	39.2
5	28.25	34.4
10	27.6	38.17
15	26.9	30.33
20	26.89	30.02

Table 6
Tensile strength of concrete; curing strength for 14 and 28 days

MarbleDust (%)	Tensile strength of concrete cylinder N/mm ²	
	14 days	28 days
0	1.4	2.2
5	1.7	2.0
10	1.65	2.5
15	1.2	1.9
20	1.21	1.7

The Compressive strength of concrete was measured for 14 and 28 days. To evaluate the effects of marble dust on mechanical behavior, many different mortar mixes were tested, all prepared with cement to sand ratio 1:3.

4. EXPERIMENTAL PROGRAMME

4.1. Materials used

Cement: Portland pozzolona cement and the properties were

Specific Gravity : 2.84
Consistency : 34%
Initial Setting Time : 1 hour 5 minutes
Final Setting Time : 5 hours

4.2. Marble Dust

The Marble Dust chosen for these experiments was white coloured. It is directly obtained from deposits of marble factories during shaping. Hence Marble Dust was sieved using 0.25mm sieve. The Specific gravity of the marble dust was found to be 2.3.

4.3. Fine Aggregate

Natural sand (maximum size 4.75mm) was used and specific gravity is 2.67.

4.4. Coarse Aggregate

Natural Aggregate (maximum size 20mm) was used and specific gravity is 2.7.

4.5. Water

The water samples are potable and are of uniform quality.

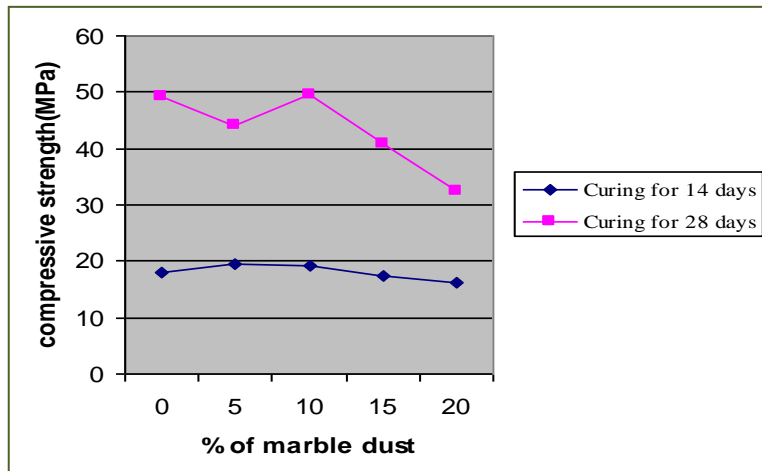


Figure 1
Compressive Strength of Mortar cube

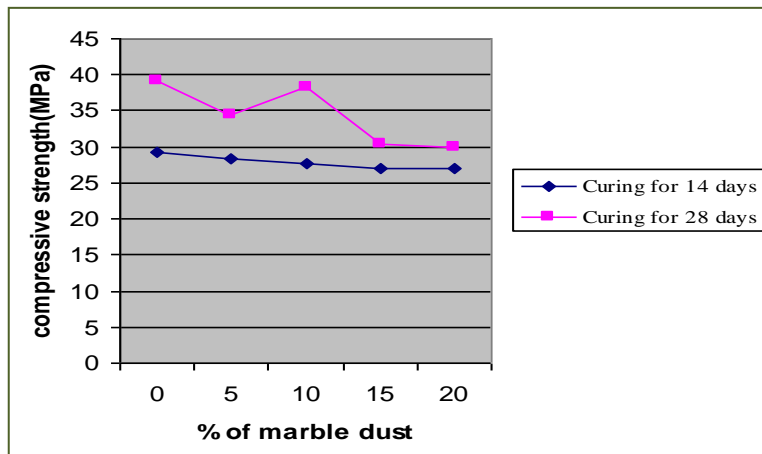


Figure 2
Compressive Strength for M20

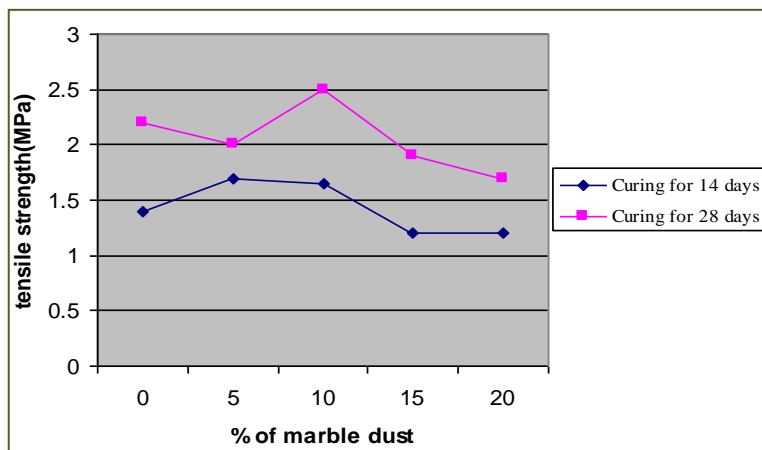


Figure 3
Tensile Strength for M20

4.6. Experimental condition

4.6.1. Mortar Mix Proportion

All mortars were prepared with the same ratio of cement to sand (Ratio 1:3). Marble dust was used for 5%, 10%, 15% and 20% replacement of cement (Table 1 & Table 3). All specimens were removed 48 hours after casting and it is cured for 14 days and 28 days and the M20 grade of concrete mix ratio is given in Table 2. The compressive strength of mortar cube is obtained for various proportion of marble dust concrete is shown in Table 4 & Figure 1. Compressive strength testing was undertaken on 15cm cubic specimens at 14 days and 28 days and tensile strength with 30cm of height and 15cm of diameter were casted and tested.

4.6.2. Mix Design

Mix design for concrete was made using the properties of constituents of concrete. Grade of concrete was taken as M20 and the Mix design was done as per IS: 10262-1981 and IS:456-2000. The water cement ratio was taken as 0.47.

5. RESULTS

5.1. Compression Strength Test

Mechanical behavior of concrete was studied for M20 grade, cubes were casted and cured for 14 and 28 days. And then the results obtained are reported in Table 5 & Figure 2 with a replacement of marble dust in % in concrete.

5.2. Tensile Strength Test

Mechanical behavior of concrete was studied for M20 grade; cylindrical specimens were casted and cured for 14 and 28 days. And then the results obtained are reported in Table 6 & Figure 3 with a replacement of marble dust in % in concrete.

6. COST ANALYSIS

For every 10 bags of cement, the addition of 10% of marble dust saves 1bag of cement and 1 bag cost.

7. CONCLUSION

From the above study, it is concluded that the marble dust can be used as a replacement for cement. Test results indicate that the 10% of marble dust in the cement concrete gives the best results. And also increase in curing days will increase the strength of marble dust concrete when compared from 14 days to 28 days.

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